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ABSTRACT

The instructor's guide is designed to present an understanding of the automotive hydraulic brake system and to help individuals develop new skills for employment in this specialized field of automotive service. Applicable for secondary or adult education, this guide describes: the brake system, types of brakes, diagnosis and correction of brake problems. The content outline is listed on the left side of the page with corresponding teaching approaches on the right. A final examination, advice on using audiovisual materials, and preparing and using transparencies follow the course outline. Instructional materials, including books, films, and slides are suggested for each section of the course. (DS)

ED 086882

Automotive Industries Occupations

AN INSTRUCTOR'S GUIDE FOR A PROGRAM IN

BRAKE SERVICES

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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TRADE AND TECHNICAL EDUCATION

THE UNIVERSITY OF THE STATE OF NEW YORK / THE STATE EDUCATION DEPARTMENT
BUREAU OF CONTINUING EDUCATION CURRICULUM DEVELOPMENT
BUREAU OF SECONDARY CURRICULUM DEVELOPMENT / ALBANY, NEW YORK 12224

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1970

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Foreword

The automotive industry is continually introducing improvements, and these changes necessitate the periodic upgrading of the service personnel. This instructor's guide for *Brake Services* was developed from the suggested services for automotive brakes that are listed in the *Automotive Service Occupations*. The content may be used in secondary schools and adult programs to assist in preparing individuals who wish to enter the automotive field or to upgrade personnel already working as automobile mechanics.

Appreciation is expressed to Howard Daley, auto mechanics instructor at the Thomas A. Edison Vocational and Technical High School, New York, for his efforts in developing the instructional materials. Assistance relating to content was provided by Edward Shattuck, Associate in the Bureau of Trade and Technical Education. The project was coordinated and the manuscript edited and prepared for publication by Nelson S. Maurer, Associate in the Bureau of Continuing Education Curriculum Development.

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Message to the Instructor

Brake Services is designed to present an understanding of the automotive hydraulic brake system and to help individuals develop new skills for employment in a specialized field of automotive service.

Plan each lesson carefully before presenting it to the class. It will be necessary to consider classwork, discussion, demonstrations, and review. The left-hand column of each unit contains suggested topics. The right-hand column gives related information and teaching techniques, methods, and tips which should help to achieve a more effective presentation. Also, this column shows page references for selected textbooks for which the complete citations and symbols are given on page 42. Give a summary of the key points discussed at the conclusion of each unit. A suggested final examination is provided at the end of this guide. The questions are derived from the basic material and are in the form of completion, matching, and multiple choice.

Use the chalkboard, overhead projector, charts, diagrams, and other visual aids to clarify the material being presented. A list of suggested aids appears at the end of each unit. Excellent instructional materials are available from various automobile and automotive equipment manufacturers but order these materials well in advance of the scheduled lesson. Specific materials might be located in *Automotive Instructional Material* published by the Automotive Service Industry Association. Many teaching aids may be fabricated from samples or discarded equipment.

New instructional aids are constantly being made available to instructors. Current releases of audiovisual aids are usually listed in issues of such publications as the *American Vocational Journal*, *Industrial Arts and Vocational Education*, and *School Shop*. New information relating to the automotive industry is available from general trade magazines as well as publications distributed by specific manufacturers.

As experience is gained with this guide, it is hoped that suggestions will be sent to the Bureau for consideration in subsequent revisions.

BERTON P. PLUMMER, *Chief*
Bureau of Trade and Technical Education

JOHN E. WHITCRAFT, *Director*
Division of Occupational Education

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Introduction

OBJECTIVES:

- To understand the content to be covered in the course
- To understand the basic operation of automotive brakes

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Importance	The safety of the operator, passengers, pedestrians, other vehicles, and property depend on the proper functioning of the vehicle's brake system. Automotive servicemen can play an important role in reducing highway accidents by following proper procedures for servicing brake systems. The purposes of this course are to provide apprentices, vocational students, and mechanics with: • A practical understanding of the principles and operation of the automotive brake system. • Procedures for diagnosing and servicing the automotive brake system
II. Course Requirements	
A. Textbook	*If a textbook is to be used, give the name, price, and source. Arrange for a group order.*†
B. Notebook	*Indicate that a looseleaf notebook is necessary for keeping class notes, job information, booklets, and materials distributed during the course.*
III. General Safety	*Discuss the use and care of various solvents used in the shop.* *Discuss the use and care of lifting devices and the procedures for lifting vehicles.*

†Textbook citations given at the end of each unit.

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Discuss the procedures for extinguishing small fires involving: • *Liquids* • *Wiring* • *Upholstery*
A. Protective clothing	*State the school policy relative to coveralls or shop coats and, if required, suggest that trainees furnish their own protective clothing. Mention possible storage space for clothes, if any exists.*
B. Safety glasses	*Indicate the school policy relative to the wearing of approved safety glasses. Arrange for a group order for those who wish to purchase safety glasses.*
IV. Overview of Course	*Discuss the general subject matter that is to be covered in each unit of the course. Also, indicate such items as the length of each session, number of sessions, procedures to be followed in class, and what is expected of each class member.* *Indicate that a final examination will be given at the end of the course to point out any weak areas.* *Note that following the test there will be time for reviewing the examination and other questions related to the course.*
V. Automotive Brakes	Automotive brakes are friction devices which change kinetic (motion) energy into heat energy. Friction is the force which opposes motion. *Discuss the process of changing kinetic energy into heat energy, and explain why and how this heat energy is dissipated during braking. (Ref. C, pp. 511-513)*
A. Factors affecting the stop	*Discuss the various factors that affect the stopping of a vehicle. Include such items as:* • *Speed and load of vehicle*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• Surface and condition of road • Condition of tire tread • Transfer of load • Area of contact • Pressure of lining against drum • Composition of lining • Temperature of lining • Braking force of engine (Ref. C, pp. 511-513)
B. Operation	Explain the basic operation of the hydraulic brake system. Include such items as: • Pressure from brake pedal to master cylinder piston • Pressure from master cylinder piston to wheel cylinder pistons • Pressure from wheel cylinder pistons to brakeshoes and brakeshoes against brake-drums. • Action of retracting springs • Advantage of dual master cylinder (Ref. B, pp. 29-1—29-2; Ref. C, pp. 513-514, 516-518) Use films, transparencies, and charts to assist in developing the topic of the operation of the brake system. See Instructional Materials at the end of the unit.
C. Self-energizing action	Explain how drum rotation tends to increase the pressure of the brakeshoe against the brakedrum. Use transparencies, charts, and the actual device to assist in developing the topic of the self-energizing action of automotive brakes. See Instructional Materials at the end of the unit. (Ref. A, pp. 347-348; Ref. C, pp. 514-515)

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
D. Servo action	*Explain how the primary shoe energizes the secondary shoe. Also include duo-servo action.* *Use transparencies, charts, and the actual device to assist in developing the servo action of automotive brakes. See Instructional Materials at the end of the unit.* (Ref. B, pp. 29-13—29-14)
E. Self-adjusting action	Most hydraulic brake systems use devices that automatically maintain the proper drum-to-lining clearance. *Explain the self-adjusting action of automotive brakes. Include such types as:* • *Star wheel and lever* • *Star wheel and cable* • *Star wheel and link* (Ref. A, pp. 349-350) *Use transparencies, charts and the actual device to assist in developing the topic of self-adjusting action of automotive brakes. See Instructional Materials at the end of the unit.*

QUESTIONS FOR REVIEW

1. List the factors affecting the stopping of a vehicle.
2. What causes fading of brakes?
3. How is heat dissipated during the braking process?
4. Explain the duo-servo action of a wheel brake.
5. Explain the self-adjusting action of automotive brakes.

INSTRUCTIONAL MATERIALS

TEXTBOOKS

(A) Stockel, M. W. *Auto mechanics fundamentals.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1969.

(B) _____ *Auto service and repair.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1969.

(C) Toboldt, W. K. & Johnson, Larry. *Motor service's automotive encyclopedia.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1968.

REFERENCE BOOKS

Bendix Corp., Friction Materials Division. *Brake facts handbook.* Cleveland, Tenn. The Division.

_____ *Brake service manual.* Cleveland, Tenn. The Division.

Chek-Chart Corp. *Car service.* Chicago, Ill. The Corporation. 1969.

H. K. Porter Co., Inc., Thermoid Division. *Brake service manual.* Pittsburgh, Pa. The Division. 1965.

FILMS

When the chips go down. Bendix, Friction Materials Division. 30 min. sound. color. Free - Modern Talking Picture Service.

TRANSPARENCIES

Brakes. DCA Educational Products, Inc. Nine transparencies. color. Purchase - DCA Educational Products, Inc.

Brakes. Universal Education and Visual Arts. Four transparencies. color. Purchase - Univeral Education and Visual Arts.

CHARTS

Automotive stopping distances. General Motors Corp. Free - General Motors Corp.

Brake system. General Motors Corp. Free - General Motors Corp.

The Brake System

OBJECTIVES:

- To understand the hydraulic principles of automotive brakes
- To understand the operation of the hydraulic component parts of automotive brakes
- To understand the operation of the mechanical component parts of automotive brakes

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES

I. Principles of Hydraulics	The brake linings are pushed against the brakedrums by applying a force to a colunm of liquid. This action is based on the following principles.
	• Confined liquids cannot be appreciably compressed. (Ref. A, p. 333)
	• Confined liquids can transmit pressure.
	  • Pressure applied anywhere on a confined liquid is transmitted equally and undiminished in every direction.
	Illustrate the above principles with a diagram of a confined liquid under pressure with gauges connected at different points throughout the system. Point out that the original pressure is transmitted undiminished throughout the system because all gauges register the same pressure. (Ref. A, p. 334)
	  • Pressure is force per unit area (pounds per square inch or p.s.i.).
	  • The forces on two pistons in a confined liquid are the same as the ratio of their areas.
	Illustrate the above prinicples with a diagram of a primary cylinder having a piston with an area of 1 square inch connected to three other cylinders having pistons with areas of 1/2 square inch, 1 square inch, and 2 square

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	inches, respectively. Point out that a force of 700 pounds applied to the primary piston exerts a pressure of 700 p.s.i. on the whole system. This force becomes 350 pounds at the 1/2-inch piston (1/2 x 700 = 350), 700 pounds at the 1-inch piston (1 x 700 = 700), and 1400 pounds at the 2-inch piston (2 x 700 = 1400). (Ref. C, pp. 513-514, 682-684)
	Discuss the principles of hydraulics as applied to a vehicle's braking system. Include such topics as:
	• *Foot pedal leverage*
	• *Master cylinder and piston operation*
	• *Transfer of pressure from master cylinder to wheel cylinders*
	• *Connecting lines from master cylinder to wheel cylinders*
	• *Wheel cylinder and piston operation*
	• *Brakeshoe assembly operation and brakedrum*
	• *Wheel cylinder size differential*
	• *Retracting springs*
	Use transparencies and charts to assist in developing the topic of the operation of a hydraulic brake system. See Instructional Materials at the end of the unit. (Ref. A, pp. 333-335; Ref. C, pp. 516-518)
II. Hydraulic Components	
A. Brake fluid	*Explain the functions and characteristics of hydraulic brake fluid. Include such characteristics as:*
	• *Transmits pressure*
	• *Chemically inert*
	• *Free flowing at all temperatures*
	• *High boiling point*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• Low freezing point • Lubricant • Long life • Compatible with other brake fluids (Ref. C, p. 518) Explain the effects on the brake system when the brake fluid vaporizes. (Ref. C, pp. 518-519) Discuss the State and federal standards that manufacturers of brake fluid must meet and the importance of using a quality product.
B. Master cylinder	Explain the functions and operation of the master cylinder from the beginning of the applied stroke to the end of the release stroke. Include the following items: • Fluid reservoir and cap • Cylinder and piston assembly • Check valve and piston spring • Metering valves • Compensatory port (Ref. A, pp. 335-338; Ref. C, pp. 513-514, 516-518) Use transparencies, charts, and the actual device to assist in developing the topic of the master cylinder. See Instructional Materials at the end of the unit. Explain the functions and operation of the dual master cylinder. (Ref. A, pp. 339-340; Ref. B, pp. 29-4—29-5; Ref. C, p. 518)
C. Brake lines	Discuss the functions and construction of brake lines including both steel tubing and flexible hosing. (Ref. A, pp. 340-341)

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
D. Wheel cylinders	*Explain the functions and operation of the wheel cylinder. Include such items as:* • *Housing* • *Pistons* • *Rubber cups* • *Expanders* • *Springs* • *Push rods* • *Dust boots* • *Size difference* *Use transparencies, charts, and the actual device to assist in developing the topic of wheel cylinders.* (Ref. A, pp. 341-342) *Discuss the various types of wheel cylinders used in hydraulic brake systems including:* • *Straight-bore, single-piston* • *Straight-bore, double-piston* • *Step-bore* (Ref. A, pp. 342-343; Ref. B, pp. 29-10—29-11)
III. Mechanical Components	
A. Brake pedal	*Explain mechanical advantage as it relates to the brake pedal arm, and show how the force applied by the foot is increased at the master cylinder piston.*
B. Brakedrums	The brakedrum bolts to the wheel hub and surrounds the brakeshoe assembly. The center section of the brakedrum is stamped steel and the outer rim is cast iron. *Explain the functions and types of brakedrums commonly used on vehicles.* (Ref. A, pp. 345-347; Ref. C, pp. 515-516)

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
C. Brakeshoes	*Explain the functions and design of brakeshoes. Include such topics as:* • *Shape of shoe* • *Web* • *Primary shoe* • *Secondary shoe* • *Retracting spring* • *Holddown clips* • *Anchor pin* *(Ref. A, pp. 343-344)*
D. Brake linings	*Explain the functions and composition of primary and secondary brake linings. (Ref. A, pp. 344-345; Ref. C, p. 515)*
E. Backing plate	*Explain the functions and construction of the backing plate. (Ref. A, p. 343)*
F. Stoplight switch	*Explain the functions and operation of stoplight switches including the mechanical and hydraulic types. (Ref. B, p. 29-24)*
G. Brake warning light switch	*Explain the functions and operation of brake warning light switches commonly used on vehicles. (Ref. A, p. 340)*

QUESTIONS FOR REVIEW

1. What are the two main sections of the master cylinder body?
2. Why are the pistons in the front-wheel cylinders usually larger than rear-wheel pistons?
3. State a basic rule regarding pressure on a liquid.
4. What is the most common type of brake lining material?
5. Why is the outer rim of the brakedrum made of different material than the center section?
6. Explain the function of the backing plate.

INSTRUCTIONAL MATERIALS

TEXTBOOKS

(A) Stockel, M. W. *Auto mechanics fundamentals.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1969.

(B) _____ *Auto service and repair.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1969.

(C) Toboldt, W. K. & Johnson, Larry. *Motor service's automotive encyclopedia.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1968.

REFERENCE BOOKS

Bendix Corp., Friction Materials Division. *Brake facts handbook.* Cleveland, Tenn. The Division.

_____ *Brake service manual.* Cleveland, Tenn. The Division.

Chek-Chart Corp. *Car service.* Chicago, Ill. The Corporation. 1969.

H. K. Porter Co., Inc., Thermoid Division. *Brake service manual.* Pittsburgh, Pa. The Division. 1965.

TRANSPARENCIES

Brakes. DCA Educational Products, Inc. Nine transparencies. color. Purchase - DCA Educational Products, Inc.

Brakes. Universal Education and Visual Arts. Four transparencies. color. Purchase - Universal Education and Visual Arts.

CHARTS

Brake system. General Motors Corp. Free - General Motors Corp.

Types of Brakes

OBJECTIVES:

- To understand the operation of automotive drum brakes
- To understand the operation of automotive disc brakes
- To understand the operation of automotive power brakes

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Drum Brakes	*Explain the functions and operation of the duo-servo, single-anchor, self-adjusting brake. Include such items as:* • *Wheel cylinder* • *Primary shoe and lining* • *Secondary shoe and lining* • *Holddown springs and clips* • *Adjusting screw and spring* • *Anchor pin and plate* • *Adjusting lever or cable* • *Retracting springs* *Use transparencies and the actual device to assist in developing the topic of drum brakes. See Instructional Materials at the end of the unit. (Ref. C, pp. 520-521)*
A. Parking brakes	The parking brake is a manually operated mechanical brake. (Ref. A, pp. 352-353; Ref. C, pp. 529-530)
1. Integral	The integral type parking brake consists of a brake lever mechanism (hand or foot) in the driver's compartment connected to the rear-wheel brakeshoes.

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Explain the functions and operation of the rear-wheel parking brake. Include such items as:
	• *Parking brake lever mechanism*
	• *Cable and conduit*
	• *Equalizing lever*
	• *Brakeshoe activating levers*
	Use transparencies and the actual device to assist in developing the topic of parking brakes.
2. Independent	The independent type parking brake consists of a brake lever mechanism in the driver's compartment connected to a brakedrum attached to the drive shaft.
	Explain the functions and operation of the drive-shaft type parking brake. Include such items as:
	• *Parking brake lever mechanism*
	• *Cable or rod controls*

	• *Brakedrum*
	  • *External or contracting type*
	  • *Internal or expanding type*

B. Electric brakes	In New York State electric brakes are required on trailers weighing over 1000 pounds.
	Explain the functions and operation of electric brakes. Include such items as:
	• *Controller or rheostat*
	• *Armature*
	• *Electromagnet*
	• *Brakeshoe actuating mechanism*
	• *Retracting spring*
	(Ref. C, pp. 534-535)

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES

II. Disc Brakes	Disc brakes reduce the tendency toward brake fade.
	
	Explain the functions and operation of the disc brake commonly used on vehicles. Include such items as:
	
	• *Advantages and disadvantages*
	
	• *Disc or rotor*
	
	• *Splash shield*
	
	• *Caliper assembly*
	  • *Piston*
	  • *Inboard and outboard lining assemblies*
	  • *Dust boots and seals*
	
	• *Metering valve*
	
	• *Proportioning valve*
	
	(Ref. A, pp. 350-352; Ref. C, pp. 522-529)

III. Power Brakes	Power brakes reduce the braking effort required by the driver and supply the extra force needed for quick stops and secure braking. Most power brake systems use the engine's intake manifold vacuum and atmospheric pressure as the source of power. *Discuss the factors that have made it necessary to increase the braking force. Include such items as:* • *Weight and speed of vehicles* • *Size limitations of the wheel cylinder* *Discuss the functions and operation of power brakes commonly used on vehicles. Include such items as the following during the released and depressed pedal positions:* • *Control chamber* • *Power chamber*

CONTENT OUTLINE

UNDERSTANDINGS AND TEACHING APPROACHES

- *Operating and control valve*
- *Power piston and diaphram*
  - *Diaphram return spring*
  - *Vacuum input and check valve*
- *Master cylinder push rod*
- *Master cylinder*

Use transparencies and the actual device to assist in developing the topic of power brake operation. See Instructional Materials at the end of the unit. (Ref. A, pp. 353-356; Ref. C, pp. 531-533)

QUESTIONS FOR REVIEW

1. How does the primary lining differ from the secondary lining?
2. What is the purpose of the equalizing lever on parking brakes?
3. Explain the operation of electric brakes.
4. What is the purpose of the metering valve on disc brakes?
5. Why is a proportioning valve necessary on disc brakes?
6. Explain the operation of the power brake.
7. Explain the difference between the internal expanding and external contracting type parking brake.
8. What factors determine the amount of effort a power brake will apply?

INSTRUCTIONAL MATERIALS

TEXTBOOKS

(A) Stockel, M. W. *Auto mechanics fundamentals.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1969.

(C) Toboldt, W. K. & Johnson, Larry. *Motor service's automotive encyclopedia.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1968.

REFERENCE BOOKS

Bendix Corp., Automotive Service Division. *The inside story of disc brakes.* South Bend, Inc. The Division.

Types of Brakes

Bendix Corp., Friction Materials Division. *Brake facts handbook.* Cleveland, Tenn. The Division.

_____ *Brake service manual.* Cleveland, Tenn. The Division.

Chek-Chart Corp. *Car service.* Chicago, Ill. The Corporation. 1969.

H. K. Porter Co., Inc., Thermoid Division. *Brake service manual.* Pittsburgh, Pa. The Division. 1965.

FILM LOOPS

Nomenclature and adjustments for self-adjusting brakes. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

TRANSPARENCIES

Brakes. DCA Educational Products, Inc. Nine transparencies. color. Purchase - DCA Educational Products, Inc.

Brakes. Universal Education and Visual Arts. Four transparencies. color. Purchase - Universal Education and Visual Arts.

Diagnosis and Correction of Brake Problems

OBJECTIVES

- To be able to conduct a customer interview that will assist in determining possible causes of brake problems
- To be able to conduct a road test to verify the customer's complaints
- To be able to adjust and correct malfunctions in drum, disc, power, and electric brake systems

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Preliminary Procedures	
A. Customer interview	*Develop with the trainees a list of items which would help a mechanic to gather all the important information from a customer. Consider such items as:* • *Nature of problem* • *Duration of problem* • *Previous repairs to brake system* • *Time or mileage since last brake service* *Have trainees role play several situations involving an interview between a mechanic and a customer. Have trainees evaluate the information gathered during each interview and suggest ways to improve communications.*
B. Road-test vehicle	Road-test the vehicle to verify the customer's comments and have firsthand information regarding the problem. *Discuss the precautions to take before making the road test. Include such items as:* • *Protecting the seat with a seat cover* • *Having clean hands and feet* • *Removing sharp tools from pockets*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Having permission to operate the vehicle* • *Selecting the area for the road test* • *Obeying all traffic laws* • *Caring for vehicle until it is delivered to the customer* *Discuss the conditions that should be noted during the road test. Relate these conditions to specific malfunctions that will have to be corrected. Include such items as:* • *Pedal action* • *Noise or chatter* • *Pull or lead* • *Grab or dive* • *Drag on wheel or wheels* • *Brake fade* • *Erratic action when wet* *Discuss the other component parts that need to be checked during the road test. Include such items as:* • *Shock absorbers* • *Wheel alinement* • *Wheel bearings* • *Steering system*
II. Brake Inspection and Adjustment	*Demonstrate the procedures for inspecting and adjusting the automotive brake system. Include such items as:* • *Brake pedal* • *Stoplight switch* • *Fluid level* • *Wheel cylinders*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• Brakeshoe assemblies • Brakedrums • Anchor pins • Seals • Contact points • Parking brakes • Bleeding hydraulic system • Brake lines and hoses • Wheel bearings • Steering parts • Shock absorbers
III. Drum Brake Service	
A. Master cylinder	*Demonstrate the procedures for checking a master cylinder on the car. Include such items as:* • Fluid level • Vent hole in filler cap • External leaks • Primary cup clearance • Internal leaks (Ref. B, p. 29-6) *Demonstrate the procedures for servicing a master cylinder. Include such items as:* • Removing cylinder from vehicle • Disassembling • Cleaning • Honing cylinder

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Repairing* • *Adjusting* • *Lubricating* • *Assembling* • *Bleeding* • *Replacing on vehicle* [Ref. B, pp. 29-6—29-8; Ref. C, pp. 540-541]
B. Brake lines	*Demonstrate the procedures for checking brake lines and hoses for:* • *Kinks* • *Dents* • *Abrasions* • *Soft spots* • *Ruptures* *Demonstrate the procedures for making a connection in the brake line.* (Ref. A, pp. 340-341)
C. Brakedrums	Inspect the brakedrum each time it is removed from the wheel. *Demonstrate the procedures for inspecting a brakedrum for:* • *Scores* • *Cracks* • *Heat checks* • *Bellmouth or taper* • *Barrel shape* • *Out-of-round* [Ref. B, p. 29-21]

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Demonstrate the procedures for removing a glassy surface from a brakedrum.
	Brakedrums that are more than 0.010 of an inch out-of-round or have scores more than 0.010 of an inch deep need to be turned or ground to restore a smooth and concentric surface. The maximum increase in drum size must not exceed 0.060 of an inch or the limits set by the manufacturer. (Ref. B, p. 29-22)
	Demonstrate the procedures for turning and grinding different types of brakedrums. (Ref. B, p. 29-22; Ref. C, pp. 537-538)
	Demonstrate the procedures for cleaning a machined brakedrum.
D. Brakeshoes	*Demonstrate the procedures for removing brakeshoes from the backing plate.* (Ref. B, pp. 29-14—29-15)
	Demonstrate the procedures for inspecting brakeshoes for:
	• *Cracks*
	• *Distortion*
	• *Broken welds*
	• *Worn or distorted anchor pin holes*
E. Brake linings	*Demonstrate the procedures for inspecting brake linings to determine:*
	• *Need for replacement*
	• *Fluid and grease contamination*
	• *Warped shoes*
	• *Oversized drums*
	Demonstrate the procedures for riveting brake linings to brakeshoes including the preparation of the shoes. (Ref. B, pp. 29-15—29-16; Ref. C, pp. 536-537)

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Demonstrate the procedures for grinding brake linings so they fit the brakedrum. (Ref. B, pp. 29-16—29-17)
	Explain the conditions that require the use of thicker or oversize brake linings. (Ref. B, pp. 29-21—29-22)
F. Wheel cylinder	*Demonstrate the procedures for checking a wheel cylinder on the car.*
	Demonstrate the procedures for servicing a wheel cylinder. Include such items as: • *Removing cylinder from vehicle* • *Disassembling* • *Cleaning* • *Honing* • *Repairing* • *Lubricating* • *Assembling* • *Replacing cylinder on vehicle* • *Connecting to brake line* • *Bleeding the cylinder* (Ref. B, pp. 28-12—29-13)
G. Backing plate	*Demonstrate the procedures for servicing the backing plate including:* • *Inspecting for damage or deterioration* • *Cleaning* • *Lubricating* • *Tightening*
	Demonstrate the attaching of the brakeshoe assembly to the backing plate for both front and back wheels. (Ref. B, pp. 29-17—29-18)

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
H. Stoplight switch	*Demonstrate the procedures for checking the operation of a stoplight switch.* *Demonstrate the procedures for removing, replacing, and adjusting a stoplight switch.*
I. Brake warning light switch	*Demonstrate the procedures for checking the operation of brake warning light switches including the:* • *Electrical circuit* • *Hydraulic circuit* *Demonstrate the procedures for removing and replacing a brake warning light switch.*
J. Parking brakes	*Demonstrate the procedures for adjusting rear-wheel type parking brakes.* (Ref. B, p. 29-24) *Demonstrate the procedures for adjusting and servicing drive-shaft type parking brakes.* (Ref. B, pp. 29-23—29-24)
K. Troubleshooting	*Develop troubleshooting procedures for brake problems. Include such items as:* • *Spongy pedal* • *Excessive pedal travel* • *Pedal goes to floor when depressed* • *Excessive brake pressure* • *Pedal hop* • *Brakes drag* • *Brakes grab* • *Brakes fade* • *Brakes chatter*
IV. Disc Brake Service	
A. Caliper assembly	*Demonstrate the procedures for servicing a caliper assembly. Include such items as:* • *Removing from spindle*

CONTENT OUTLINE		UNDERSTANDINGS AND TEACHING APPROACHES
		• *Disassembling* • *Cleaning* • *Repairing* • *Assembling and alining* (Ref. B, pp. 29-25—29-30; Ref. C, pp. 522-528)
	B. Disc	*Demonstrate the procedures for servicing a disc including:* • *Thickness check* • *Runout* (Ref. B, p. 29-29)
	C. Proportioning and metering valves	*Demonstrate the procedures for removing and replacing proportioning and metering valves.* (Ref. B, pp. 29-30—29-31)
V.	Power Brake Service	*Demonstrate the procedures for servicing the power brake unit including:* • *Removing from vehicle* • *Disassembling* • *Repairing* • *Assembling* • *Attaching to vehicle* • *Adjusting*
VI.	Electric Brake Service	*Demonstrate the procedures for adjusting and servicing electric brakes commonly used on trailers.* *Have trainees service automotive brake systems until they develop enough proficiency to be able to enter the field as an automotive brake mechanic. Include such jobs as:* • *Conducting customer interviews* • *Road-testing vehicles*

CONTENT OUTLINE

UNDERSTANDINGS AND TEACHING APPROACHES

- *Servicing drum brakes*
- *Servicing disc brakes*
- *Servicing power brakes*
- *Servicing electric brakes*

QUESTIONS FOR REVIEW

1. Name the causes and corrections for a spongy brake pedal.
2. Explain how to inspect brakeshoes.
3. Name five problems that could be detected by examining the brake lining.
4. Explain the general practice for determining when to use oversized or standard thickness linings.
5. Explain the procedure for adjusting the internal expanding transmission mounted parking brakes.
6. Explain how to adjust the external contracting transmission mounted parking brake.
7. Explain how to adjust rear-wheel parking brakes.

INSTRUCTIONAL MATERIALS

TEXTBOOKS

(A) Stockel, M. W. *Auto mechanics fundamentals.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1969.

(B) _____ *Auto service and repair.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1969.

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Wagner Electric Sales Corp. *Brake maintenance manual.* Newark, N.J. The Corporation.

35 mm. SLIDES

Fundamentals of disc brake service. Bear Manufacturing Co. 47 slides color. Purchase - Bear Manufacturing Co.

Fundamentals of drum brake service. Bear Manufacturing Co. 54 slides. color. Purchase - Bear Manufacturing Co.

FILM LOOPS

Arcing brake shoes. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

Assembly procedures for disc brakes. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

Assembly procedures for self-adjusting brakes. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

Bleeding hydraulic brakes. Modern Talking Picture Service. Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

Disassembly procedures for disc brakes. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

Disassembly procedures for self-adjusting brakes. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

How to machine a disc rotor, part I and II. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

How to roto-finish a disc. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

Nomenclature and adjustments for self-adjusting brakes. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

Rebuilding brake wheel cylinders. Modern Talking Picture Service, Inc. Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

Rebuilding the master cylinder. Modern Talking Picture Service, Inc. Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

Replacing Bendix brake shoes. Modern Talking Picture Service, Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

Turning front brake drums, part I and II. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

TRANSPARENCIES

Brakes. DCA Educational Products, Inc. Nine transparencies. color. Purchase – DCA Educational Products, Inc.

Brakes. Universal Education and Visual Arts. Four transparencies. color. Purchase - Universal Education and Visual Arts.

Final Examination

Final Examination Part I — Fill-In Statements

Directions: For each statement, write the item or phrase that, when inserted in the blank, will correctly complete the statement.

1. The two main sections of the master cylinder body are RESERVOIR and PRESSURE CHAMBER.

2. Nonflexible brake lines are generally made of STEEL.

3. Excess hydraulic fluid in the brake wheel cylinders is returned to the reservoir by way of the COMPENSATING PORT and BREATHER PORT.

4. Air in the hydraulic system can be exhausted by BLEEDING the brakes.

5. The wedging action of the brakeshoes is termed SELF-ENERGIZATION.

6. The ability of the primary shoe to transfer motion to the secondary shoe is termed SERVO-ACTION.

7. The operating temperature of disc brakes is LOWER than on brakes of the conventional type.

8. The resistance to motion between two objects in contact with each other is called FRICTION.

9. The brakeshoe assembly is attached to the BACKING PLATE.

10. A small amount of air in the hydraulic system would cause A SPONGY pedal action.

11. Hydraulic pressure may be TRANSMITTED through a flexible tube.

12. Brakes tend to fade when they are HOT.

13. The cable operated self-adjusting mechanism operates when the wheel rotates in the REVERSE direction.

14. Pressure is held in the brake system by a CHECK VALVE.

15. The solvent to use when cleaning a wheel cylinder is ALCOHOL.

16. Liquids can transmit PRESSURE.

17. The purpose of the master cylinder is to PRODUCE PRESSURE.

18. The reservoir of the master cylinder should be filled to within $\frac{3}{8}$ - $\frac{1}{2}$" of the top.

19. A clogged compensating port will cause the brake to DRAG OR LOCK.

20. Wheel cylinders are usually fastened to the BACKING PLATE.

21. Brake linings are composed mostly of ASBESTOS.

22. A proportioning valve is used with DISC brake systems.

23. Brakes that automatically maintain the proper drum-to-lining clearance are called SELF-ADJUSTING.

24. Brakes change kenetic energy into HEAT ENERGY.

25. Confined liquids cannot be appreciably COMPRESSED.

Final Examination Part II — Matching

Directions: In the space provided to the left of each item in Column I, write the letter of the word or phrase from Column II which best defines the item in Column I.

Column I	Column II
1. H Compensating	A. Type of parking brake
2. G Chemically inert	B. Head nut
3. A External contracting	C. Wheel cylinder
4. J Finned drum	D. Push rod
5. M Servo action	E. Self-energization
6. L Static pressure	F. Asbestos
7. K Star wheel and lever	G. Brake fluid
8. C Step bore	H. Master cylinder
9. O Metering valve	I. Power brake unit
10. E Wedging action	J. Dissipate heat
	K. Self-adjusting mechanism
	L. Check valve
	M. Secondary shoe
	N. Internal expanding
	O. Disc brakes

Final Examination Part III — Multiple Choice

Directions: For each statement place an X in the space to the left of the choice that most accurately completes the statement.

1. The check valve of the master cylinder is located in the

   ____ (a) reservoir
   __X__ (b) pressure chamber
   ____ (c) breather port
   ____ (d) piston

2. The secondary cup is located on the

   ____ (a) wheel cylinder
   ____ (b) reservoir
   ____ (c) flexible lines
   __X__ (d) piston

3. A metering valve would most likely be found in the hydraulic system of

   ____ (a) air brakes
   ____ (b) conventional brakes
   __X__ (c) disc brakes
   ____ (d) electric brakes

4. The recommended maximum allowable oversize diameter for reconditioned drums is

   __X__ (a) .060 in.
   ____ (b) .125 in.
   ____ (c) .030 in.
   ____ (d) .120 in.

5. The material used for the braking surface of brakedrums is

   __X__ (a) cast iron
   ____ (b) wrought iron
   ____ (c) steel
   ____ (d) bronze

6. A properly adjusted brake pedal would have free movement of

   ____ (a) $\frac{1}{32}$" - $\frac{1}{16}$"
   __X__ (b) $\frac{1}{8}$" - $\frac{1}{4}$"
   ____ (c) $\frac{3}{8}$" - $\frac{1}{2}$"
   ____ (d) $\frac{1}{2}$" - $\frac{9}{16}$"

7. The proportioning valve in disc brakes

_____ (a) prevents simultaneous failure of both front and rear brake systems
_____ (b) controls pressure to front-wheel cylinders
_____ (c) controls disc brake application until a specific brake line pressure is reached
__X__ (d) controls pressure to rear-wheel cylinders

8. Brake fluid is returned to the reservoir by the action of

_____ (a) push rods
_____ (b) air pressure
__X__ (c) retracting springs
_____ (d) vacuum

9. Damaged brake lines should be replaced with

_____ (a) brass tubing
_____ (b) single-wall steel tubing
_____ (c) copper tubing
__X__ (d) double-wrapped, coated steel tubing

10. Bleeding screws are supplied in the

_____ (a) brake lines
_____ (b) reservoir
__X__ (c) wheel cylinders
_____ (d) pressure chamber

11. The solvent for cleaning hydraulic brake parts should be

_____ (a) water
_____ (b) kerosene
_____ (c) mineral spirits
__X__ (d) alcohol

12. The secondary brakeshoe usually faces

_____ (a) down
_____ (b) towards the front of the vehicle
__X__ (c) towards the back of the vehicle
_____ (d) up

13. Static pressure is maintained in the brake lines by a

__X__ (a) check valve in the master cylinder
_____ (b) proportioning valve
_____ (c) slight pressure on the brake pedal
_____ (d) retracting springs

14. A brake system with dual master cylinders

_____ (a) requires less brake pedal pressure
__X__ (b) provides separate pressure to front and rear wheels
_____ (c) provides an auxiliary master cylinder in case of an emergency
_____ (d) provides an additional reservoir for the brake fluid

15. Friction pads are generally found in the

__X__ (a) caliper
_____ (b) rotor
_____ (c) master cylinder
_____ (d) vacuum chamber

Using Audiovisual Materials

Audiovisual materials are both a tool for teaching and an avenue for learning. While no particular amount of time is recommended for using audiovisual materials, it is suggested that they be used with a variety of learning activities and that the instructor not devote an entire class session to the use of such materials.

Audiovisual materials lend themselves well to bring about a high level of involvement. When working with adults, it is well to remember that much can be learned from each other. It is with the idea of getting people involved and having them make contributions, that these comments are made.

The following suggestions may assist the instructor as he prepares an overall plan for the use of audiovisual materials. The ideas presented should allow for a comprehensive coverage of the content and the efficient use of class time. Steps to consider are:

- Plan the presentation (organization and methods)
- Prepare the equipment and materials
- Orient the class (background material)
- Present the lesson
- Summarize concepts and understandings
- Evaluate knowledges acquired
- Followup with opportunities to explore new knowledges
- Return the equipment and materials

Plan the Presentation (Organization and Methods)

Always preview any audiovisual material to become familiar with its content and to see that it correlates with the lesson. Adult students dislike "time fillers" and inappropriate presentations. While previewing, prepare comments which might answer such questions as:

- What is being illustrated?
- Why is the presented material important?
- What are the important terms and understandings being presented?
- What are some appropriate topics which could be used to stimulate class discussions?

Prepare the Equipment and Materials

Request the required equipment several days ahead of time from the director of adult education or person in charge of audiovisual equipment. Then see that it is delivered prior to the starting of the class. Before the class begins, practice using the equipment to become acquainted with its operation. Arrange the room so that everyone can see and is confortable. Have a screen ready and place it so that the least amount of outside light

is reflected onto it. The wall may be used, but a screen is much more desirable. The larger the room and the larger the audience, the larger the screen that is needed. Be sure there is a table for the projector, an electrical outlet, an extension cord (the cord with the projector is usually short), and a spare projector lamp available in case the one in use fails.

If the class is held during the day, be sure the room can be darkened and ventilated. Check to see if the lights can be turned off without shutting off the power to the projector. At the conclusion of the presentation, allow the fan on the machine to cool the equipment for a few minutes before completely shutting off the power to the projector.

Orient the Class (Background Material)

Explain to the class what they will see. Discuss the more important terms used and indicate the main points to be presented.

Present the Lesson

Have the film threaded and the projector ready for use. Stop the film or filmstrip for discussion as the need arises during the showing instead of waiting until the presentation has been completed. A filmstrip offers flexibility for it may be used as a whole or as a part whichever is appropriate to the lesson. It may also be stopped at any frame for discussion or questions. At the end of the showing give your comments and encourage discussion and questions from the trainees.

Summarize Concepts and Understandings

Itemize the important learnings on the chalkboard as they are contributed by the class. Allow time for the trainees to raise other questions which may lead to a more complete understanding. Encourage trainees to keep some kind of notation for future review.

Evaluate Knowledges Acquired

Prepare a list of questions which might assist trainees to evaluate how well they have learned the important points of the lesson. One approach might be for the instructor to present the question and pause for a few moments to allow the trainees to form their answers before responding. Interest could be generated by asking the trainees to keep track of the number of their correct answers.

Followup with Opportunities to Explore New Knowledges

Introduce a few new topics for discussion which will motivate the trainees to project their understandings.

Return the Equipment and Materials

After the class is over make arrangements to return the equipment and school-owned audiovisual materials. For an item ordered from an out-of-school source, complete the required attendance report, prepare the material for mailing, and leave it so that it may be returned promptly.

Preparing and Using Transparencies

Materials for use on the overhead projector may be prepared by hand, the heat-transfer process, and the color-lift process. Each method is described briefly for those who might wish to make their own original transparencies.

General Suggestions

- Select only content that is appropriate for an overhead transparency.
- Keep content of transparency simple.
- Organize the content of the transparency carefully.
- Use multiple overlays (one transparency over another) for the development of a concept or to show steps.
- Keep master and overlays in register with crosshair registration marks in opposite corners.
- Use color to make the transparency attractive but only enough color for emphasis. Color-toned sheets or colored ink may be used to identify parts of a drawing or picture.
- Plan transparency for horizontal projection.
- Use letters and symbols that are at least $\frac{1}{4}$-inch high. Use a lettering guide or dry-transfer letters and symbols to produce attractive titles or labels.
- Leave a $\frac{3}{4}$- inch clear margin on all sides of the transparency.
- Use a pointer to identify a specific part and then remove it quickly or lay pointer on transparency, for a hand-held pointer cannot be kept steady, and therefore, becomes distracting.
- Use a sliding or hinged mask to control the rate of disclosure when more than one step is included on a transparency.

Handmade Process

Produces a simple and inexpensive transparency.

Materials Needed

Plastic sheet or roll - clear or frosted

Markers - grease pencil or pen
Ink - transparent or india

Suggested Procedures

- Mark directly on the plastic sheet. This may be done in front of the class as the lesson is being given or may be prepared ahead of time.

- Remove materials placed on a handmade transparency with a sponge or cloth moistened with water or a special cleaning fluid. Then the transparency is ready to be used again.

Heat-Transfer Process

Produces a transparency from almost any original that is flexible and no thicker than a sheet of paper.

Materials Needed

Plastic sheets
Item to be copied
Copying machine

Suggested Procedures

- Material to be copied can be opaque or transluscent but should have a carbon-type ink base *(black)*.

- Follow the directions for the specific copying machine and use the recommended type of plastic sheets.

Color-Lift Process — Drymount Press

Produces a transparency by transferring the ink of a printed picture to a sheet of transparent film. Only material printed on a clay-based paper may be used.

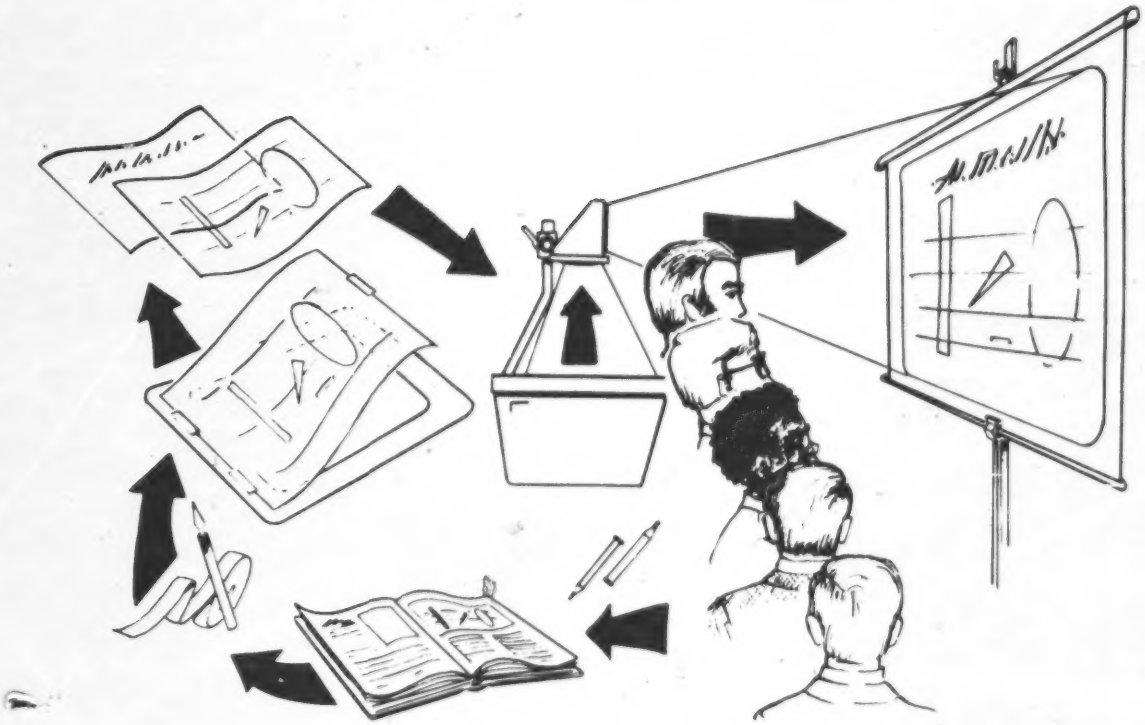
Materials Needed

Special film
Detergent
Flat tray
Drymount press
Pressure boards
Item to be transferred

Suggested Procedures

- Select and test the picture to be lifted. Wet the fingertip and rub over an unprinted portion of the page. Clay-based papers will leave a white residue on fingertip.

- Dry the picture for 5 seconds in a drymount press set at 270° F.
- Put the picture on the coated side of the special film and place between pressure boards. Heat resulting sandwich for 2-3 minutes in a drymount press set for 270° F.
- Place picture and film in lukewarm water containing a liquid detergent. Soak for 2 minutes or until the paper pulls easily from the acetate.
- Wash clay coating from picture and dry film carefully.
- Spray ink surface with clear lacquer spray. Allow spray to dry, then mount transparency.



PREPARING AND USING TRANSPARENCIES

Glossary

Aline: Bringing parts into the correct position in respect to each other or to a predetermined location.

Anchor pin: The steel stud which prevents the brakeshoes from rotating with the drum.

Asbestos: A heat resistant and nonburning fibrous mineral.

Backing plate: The rigid steel plate which holds the brakeshoes.

Brake antiroll device: A unit which holds pressure in the brake lines when the vehicle is stopped on an upgrade.

Brakeband: A band, faced with brake lining, that encircles a brakedrum.

Brake bleeding: The removal of air from the hydraulic system.

Brakedrum: A cast iron or aluminum housing, bolted to the wheel, that rotates around the brakeshoes.

Brakedrum lathe: A machine to refinish the inside of a brakedrum.

Brake fade: The loss of friction between brakeshoes and drum caused by excessive heat.

Brake fluid: A special fluid used in hydraulic brake systems.

Brake flushing: Cleaning the brake system with alcohol or brake fluid.

Brake lining: A friction material fastened to the brakeshoes.

Brake pedal free travel: The distance the brake pedal moves before the push rod engages the master cylinder piston.

Brakeshoe grinder: A grinder used to grind brake linings.

Brakeshoes: The part that holds the brake lining.

Brake warning light: A light that glows when the pressure in the hydraulic system fails.

Caliper: The part of disc brakes which goes over the disc and contains the hydraulic components.

Centrifuse brakedrums: Brakedrums that have a lining of cast iron sprayed on the inside of the drum.

Check valve: A valve that opens to permit the passage of fluid or air in one direction and closes to prevent passage in the opposite direction.

Clearance: The amount of space between two parts.

Coefficient of friction: The measurement of the amount of friction developed between two objects when one object is drawn across the other.

Compensating port: A small hole in a brake master cylinder to permit fluid to return to the reservoir.

Diaphragm: A flexible cloth-rubber sheet stretched across an area to separate two different compartments.

Disc: The circular plate against which brake lining is forced to retard the movement of a vehicle.

Disc brake: A braking system that uses a steel disc with a caliper type lining application.

Double flare: The end of a tube so flared that the area uses the thickness of two walls.

Dual brake system: A design that uses two master cylinders to provide separate hydraulic systems for front and rear wheels.

Energy: The capacity for doing work.

Feeler gauge: A thin strip of hardened steel that is used to check clearances between parts.

Flaring tool: A tool used to form flare connections on tubing.

Friction: The resistance to movement between any two objects when placed in contact with each other.

Hard pedal: An excessive amount of pressure that is needed to actuate the brakes.

Heel (brake): The end of the brakeshoe which rests against the anchor pin.

Hone: The removal of metal with a fine-grit abrasive stone to precise tolerances.

Hydraulic brakes: Brakes that are operated by hydraulic pressure.

Hydraulics: The science of liquids in motion.

Low brake pedal: A condition where the brake pedal approaches too close to the floorboard before actuating the brakes.

Master cylinder: The single or dual hydraulic cylinder which is used to force the hydraulic fluid into the individual wheel cylinders when brakes are applied.

Orifice: A small opening in a tube, pipe, or valve.

Parking brake: A hand operated brake which prevents the vehicle from moving while parked.

Pascal's law: Pressure exerted on a confined liquid is transmitted undiminished in every direction.

Port: Openings in cylinders.

Power brakes: A conventional hydraulic brake system that utilizes engine vacuum to apply pressure to the master cylinder piston.

Pressure bleeder: A device that forces brake fluid, under pressure, into the master cylinder so that all of the air may be removed during the bleeding of the hydraulic system.

Primary brakeshoe: The brakeshoe that is installed facing the front of the car.

Push rod: The connecting link in an operating mechanism.

Score: A scratch or groove on a finished surface.

Secondary brakeshoe: The brakeshoe that is installed facing the rear of the car.

Self-energizing: A brakeshoe that develops a wedging action which actually assists or boosts the braking force applied by the wheel cylinder.

Servo action: Brakes so constructed that the primary shoe activates the secondary shoe.

Spongy pedal: A brake pedal that has a springy or spongy feeling when the brakes are applied.

Static pressure (brakes): A certain amount of pressure that always exists in the brake lines.

Toe (brakes): The free end of the brakeshoe.

Vacuum runout point: The point reached when a vacuum brake power piston has built up all the braking force it is capable of with the vacuum available.

Wheel cylinder: The part of the hydraulic brake system that receives the pressure from the master cylinder and in turn pushes the brakeshoes against the brakedrums.

Directory

American Vocational Journal
American Vocational Association, Inc.
1510 H St. NW.
Washington, D.C. 20005

Automotive Service Industry Assoc.
230 North Michigan Ave.
Chicago, Ill. 60601

Bendix Corp.
Automotive Service Division
South Bend, Ind. 46620

Bendix Corp.
Friction Materials Division
Cleveland, Tenn. 37311

Chek-Chart Corporation
222 West Adams St.
Chicago, Ill. 60606

Chilton Book Co.
401 Walnut St.
Philadelphia, Pa. 19106

DCA Educational Products, Inc.
4865 Stenton Ave.
Philadelphia, Pa. 19144

General Motors Corp.
Public Relations Staff
Detroit, Mich. 48202

Goodheart-Willcox, Inc.
18250 Harwood Ave.
Homewood, Ill. 60430

H. K. Porter Co., Inc.
Thermoid Division
Pittsburgh, Pa. 15219

Industrial Arts and Vocational Education
P.O. Box 1616
Riverside, N.J. 08075

Modern Talking Picture Service
Modern Learning Aids Division
1212 Avenue of the Americas
New York, N.Y. 10036

Motor Book Division
Hearst Magazines
250 West 55th St.
New York, N.Y. 10019

Raybestos-Manhattan, Inc.
Grey-Rock Division
Manheim, Pa. 17545

School Shop
Prakken Publications
416 Longshore Dr.
Ann Arbor, Mich. 48107

Universal Education and Visual Arts
221 Park Avenue South
New York, N.Y. 10003

Wagner Electric Sales Corp.
1 Summer Ave.
Newark, N.J. 07104

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_____ *Brake service manual.* Cleveland, Tenn. The Division.

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